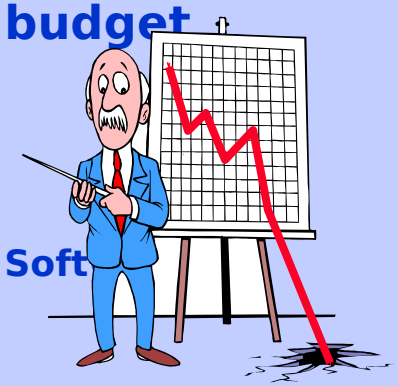
Understanding the Business Case for Best Practices

Objective:

- **Identify the Business Case for best practices and process improvement**

Do Projects Deliver Quality Products on Time and within Budget?

- Nearly 1/3 of information technology (computer and software) projects were cancelled before completion
- Average overrun of project budgets was 189%
- The average schedule overrun for projects that were in difficulty was 222%
- On average, the delivered product contained only 61% of the originally-specified features.
- Only 16% (1 of 6) software projects were completed on time, on budget



Soft

"Charting the Seas of Technology: The CHAOS Study"
The Standish Group, January 1995
- Report of the Defense Science Board Task Force on Defense
November 2000

Traits of Successful Organizations

Research of advanced / higher maturity organizations (CMM/CMMI) found similarities among them:

- **PI and use of best practices are recognized as a standard business practice, not a voluntary exercise, and included in all strategic and business plans as an organization's goal**
- **Management commitment and involvement are obvious at all levels at all times**
- **Measured progress is reported to management**
- **A dedicated, motivated, respected, and experienced PI Team is in place**
- **PI is run as a project (plan and track, allocate resources, reviews, etc.) at the organization level**
- **In every case, dollar Return on Investment (ROI) was realized, yearly reduction in time-to-market and post-release defects was achieved, and customer and employee satisfaction increased**

What are Best Practices?

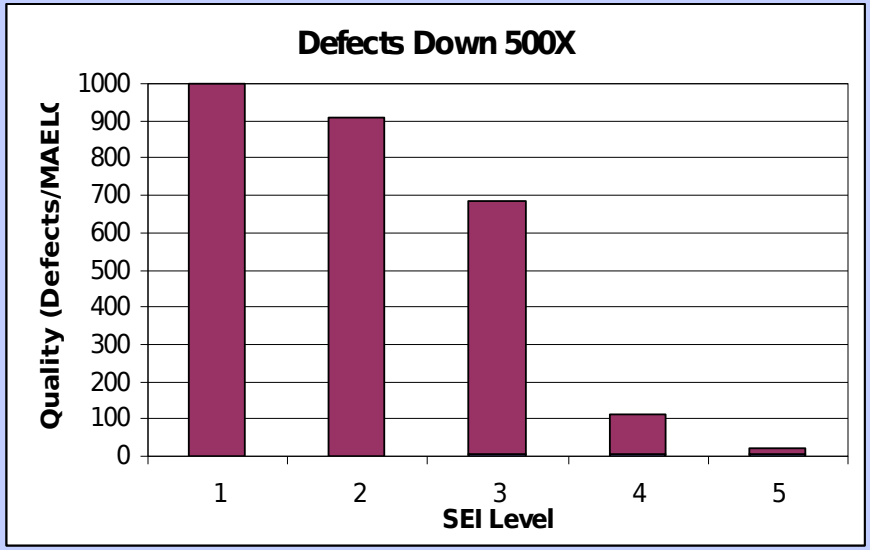
They are effective, high-leverage technical and management processes that have been implemented and proven on successful projects.

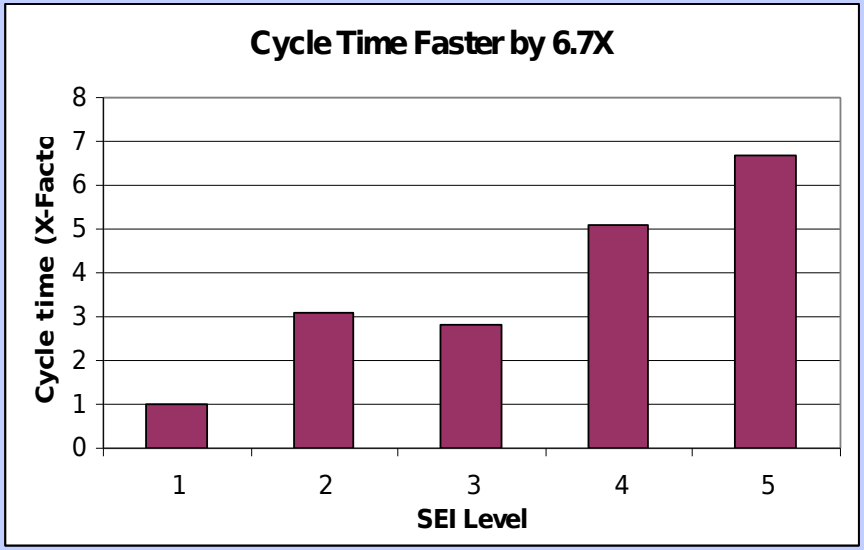
Example BPs	Benefits
• Project Planning processes	Establish schedule, resources,
• Measurement and Control	Provide visibility into progress
• Peer Reviews	Identify and eliminate defects
• Risk Management	Reduce likelihood of surprises
• Configuration Management through lifecycle	Control work produ
• Quality Assurance	Verify adherence to requi
• Status Reporting	Keep stakeholders inform
• Effective Meetings	Make meetings productive

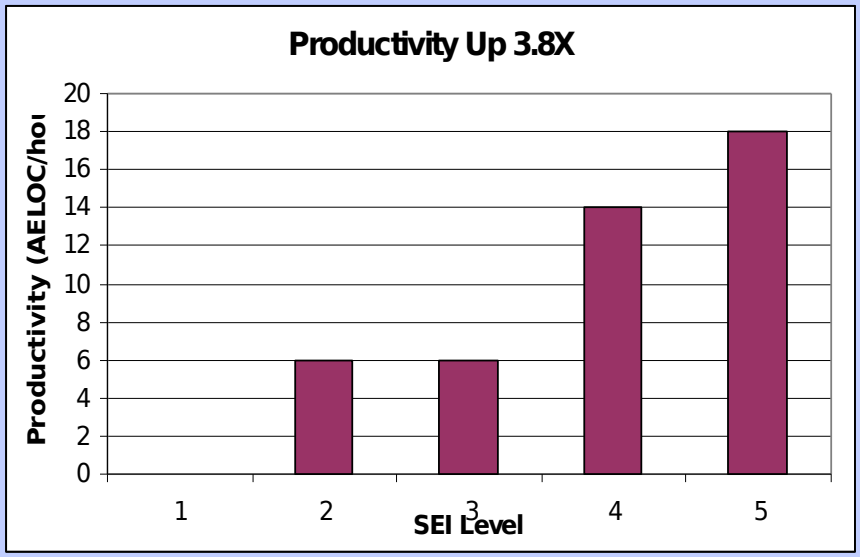
Examples of Return on Investment - CMM

- Software Engineering Institute 1994 study of 13 organizations engaged in PI showed average of 5:1 ROI
- Navy FMSO reported a savings of over $2 million through use of Formal Inspections alone (used SEPO's processes as foundation of PI effort)
- Air Logistics Center reported a 7.5:1 ROI with tenfold increase in productivity
- Raytheon achieved a 7.7:1 ROI with 2:1 productivity gains, defect rate reduced by 4.2X, reduced testing effort by half. Received $9.6M bonus for early delivery
- PRC reduced defects in documentation by 78%, defects in code by 70%, defects found operationally by 60%, ability to meet monthly cost goals increased by 40%
- Boeing found cycle time was reduced up to 50%, productivity was increased by 240%, and realized a cost-to-benefit ratio of 1:7
- Ogden Air Logistics Center spent ~$5M to reach Level 5; received over $100M in new work (19-to-1 ROI)

Process Improvements at Motorola



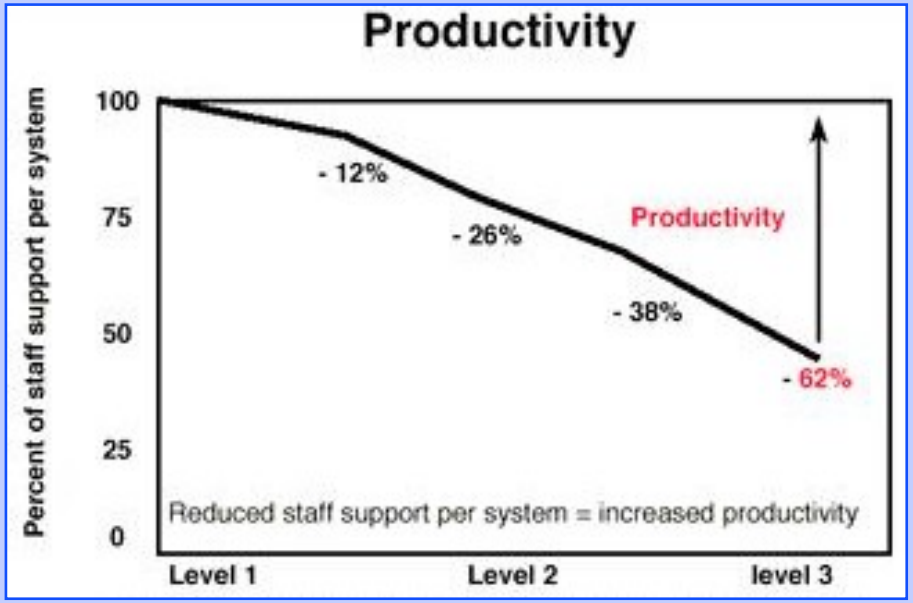




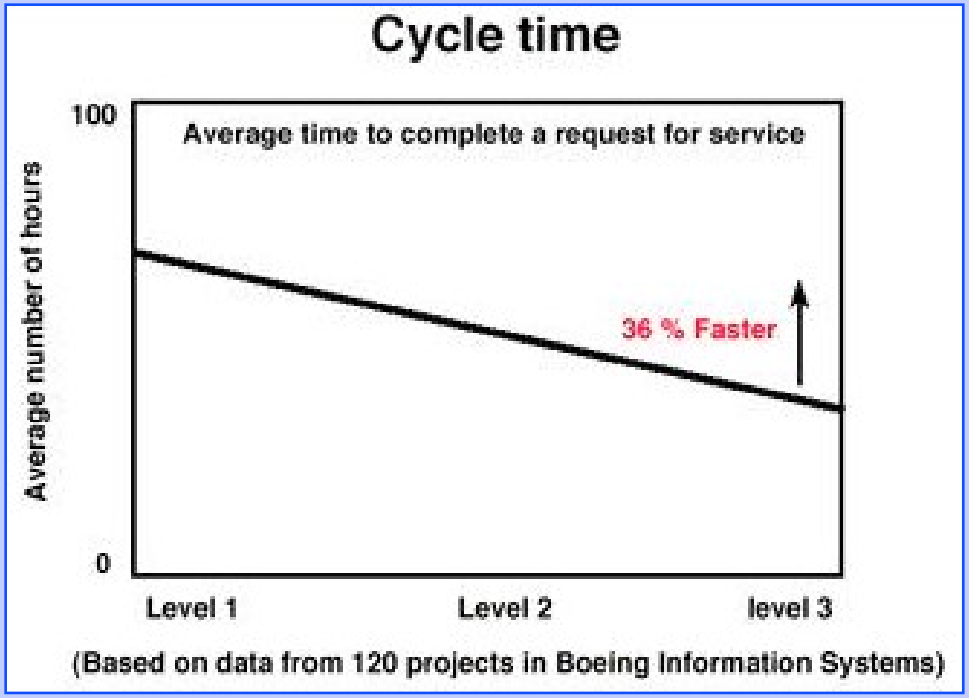
	1996	1997	1998
SEI CMM Level	2	3	4
Inspection Efficiency	1	1.68	2.00
Defect Density, per KSLOC	1	.54	.47
Build Cycle Time	NA	1	.19
Test Rate, KLOC/Days	1	4.7	20
Test Rate, reqts/week	1	1	2.7
Test Productivity, LOC/Stf Wk	1	1.66	3.07

- Motorola, Systems Solutions Group, SPIN 9/5/98

Tangible Benefits at Boeing - 1



Projects operating at Maturity Level 3 increased productivity by 62% ...

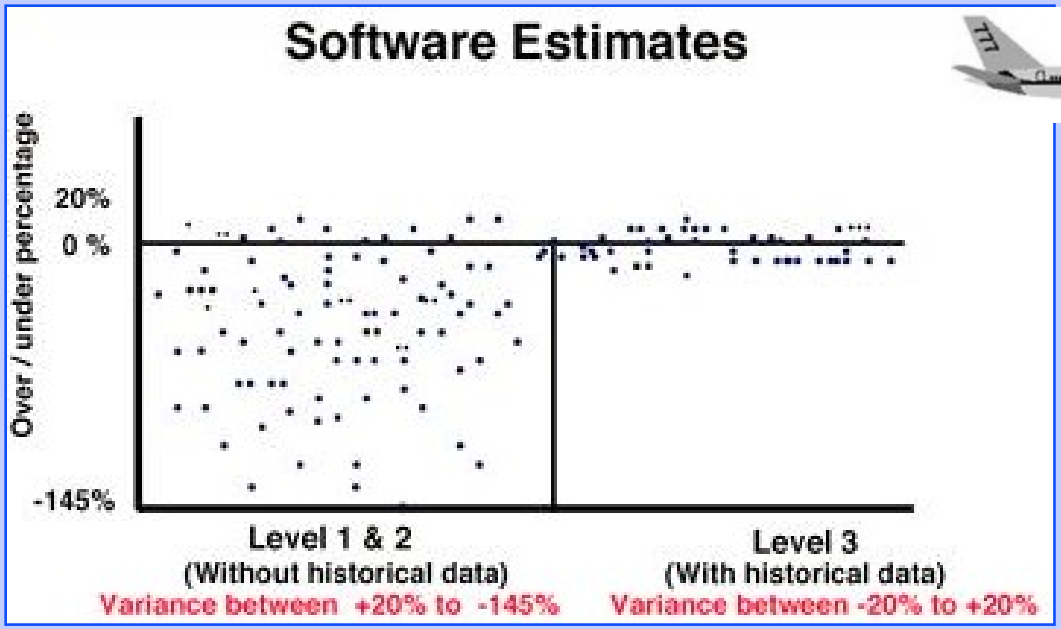


While cycle times improved 36%.

Reference: Boeing CIO, SEPG Conference 2000

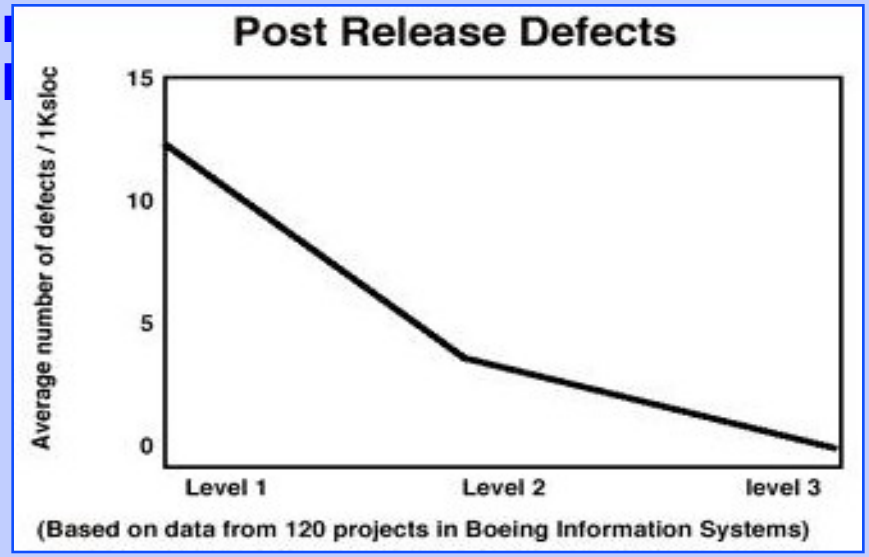
Tangible Benefits at Boeing - 2

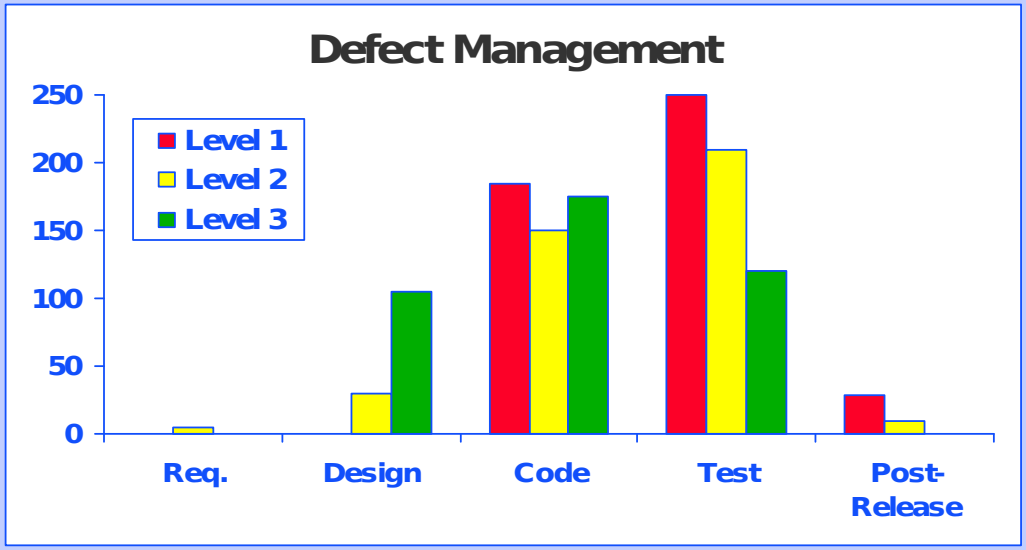
Planning was more accurate.



Product quality increased with rising

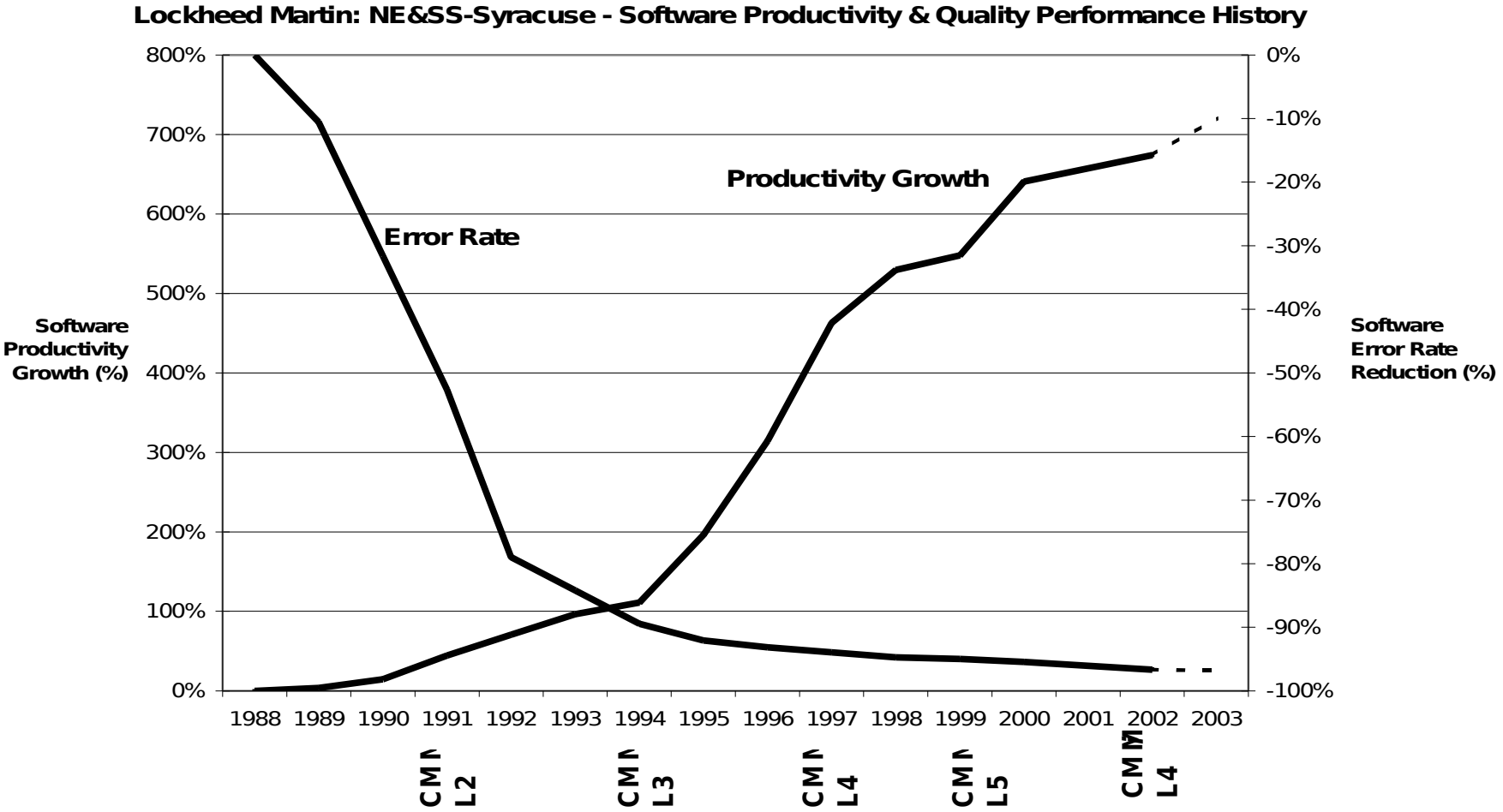
Defects could be detected earlier.





Benefits at Lockheed Martin

LOCKHEED MARTIN



Software Productivity and Quality Performance Application of Best Practices and Investment Has Resulted in Significant Improvements in Quality and Cost. As error rates declined, productivity increased by 80+%.

ROI for the F/A-18 Advanced Weapons Lab, China Lake

- Major upgrades to 10 million words of code in 40 different processors
- Adopted CMM and achieved Level 4
- Changes over latest 4 major upgrades over 10 years:
  - Reduced cycle time from 56 months to 38 months
  - Reduced schedule slips from 12 months to on time
  - Decreased rework rate from 20:1 to 3:1
  - Decreased regression testing from 70% to 20%
  - Decreased redundant testing from 100% to 10%
  - Reduced defect density from 13.5 defects per KSLOC to 3.8
  - Reduced life-cycle cost from $1,170 per SLOC to $400
  - Reduced test flights from 3.1 per KSLOC to 0.6
  - No fleet problems reported in three years
- Named one of “Top 5 Quality Software Projects” in Jan 2002 CrossTalk
  - “Very well planned and managed” - Capers Jones, judge
  - “Size, complexity, and number of systems involved represent a significant technical challenge in itself” - Watts Humphrey, judge

See http://www.stsc.hill.af.mil/crosstalk/2002/jan/jan02.pdf

Transitioning to CMMI: Benefits and Return on Investment

- **Recently reported CMMI data shows quantitative and qualitative benefits may be demonstrated through:**
  - **Switching from previous process improvement models** (e.g. SW-CMM, SE-CMM, EIA-731) **to CMMI**
  - **New or modified processes**
  - **Broadened organizational scope of improvement efforts to include systems engineering, hardware and related disciplines**
- **Summary of data reports cost savings, and improvements in schedule, quality and customer satisfaction measures**
  - **Cost reductions in intermediate and final work products and processes employed to produce products**
  - **Schedule improvements in predictability and cycle time**
  - **Quality improvements via reduction in defects**

ROI Data from Ft. Sill* - CMMI L5 (1)

- **Life cycle maintenance engineering center for U.S. Army CECOM, staffed by 30 government and 300 contractors**
- **Fielded seventy-three software versions, transitioned eight weapons systems, developed twenty new fire support systems**
- **Joint teams handle over 9.5 million SLOC (80% new development, 20% defect repair)**

Tangible / Quantifiable Benefits

- **1.5M to 9.5M SLOC with NO staff increase needed.**
- **250% improvement in ability to accurately predict size of product for staffing and cost estimates.**
- **83.57% decrease in defects per KLOC:**
  - **From 1.40 to .23 defects per KLOC (from last to current version)**
- **LOC per hour rate has increased by 48%.**
- **Using average inflation over thirteen years, if old processes were kept, operating cost would be $59M per year. Continuous improvement has made the average operating cost $30M per year.**

** Excerpts from "An Analysis of Ft. Sill's CMMI ROI/Benefits"*

ROI Data from Ft. Sill* - CMMI L5 (2)

Intangible / Qualitative Benefits

- Creativity and ingenuity encouraged from staff
- Staff appreciates formal inspection process, which in turn contributed to early defect reduction
- Reduced post-delivery defects gives engineers time for follow-on efforts instead of rework and retest
- A shared development platform has allowed staff to move easily between projects
- Staff liked not having to guess at “how” to do tasks
- People who use the processes defined the processes, giving pride of ownership and buy-in

** Excerpts from “An Analysis of Ft. Sill’s CMMI ROI/Benefits”*

Lockheed Martin - Management & Data Services
System & Software Integration

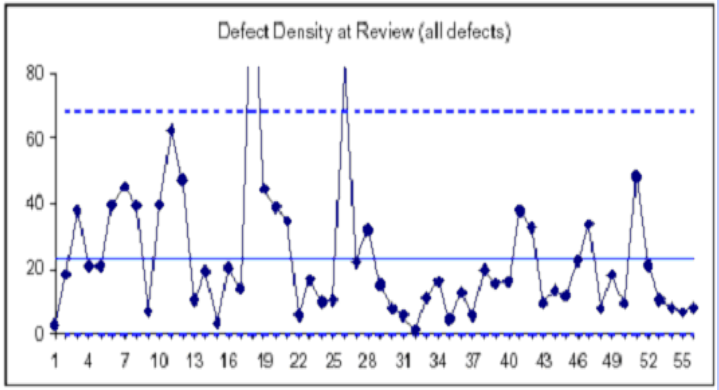
- From SW CMM ML2 (1993)
  to ML 3 (1996)
  and then to
  CMMI ML5 (2002)
- Data from their continuing improvement program reports:
  - Increased software productivity by 30%
  - Decreased unit software cost by 20%
  - Decreased defect find and fix costs by 15%
  - Reduced overhead costs of ~ 5%

LOCKHEED MARTIN

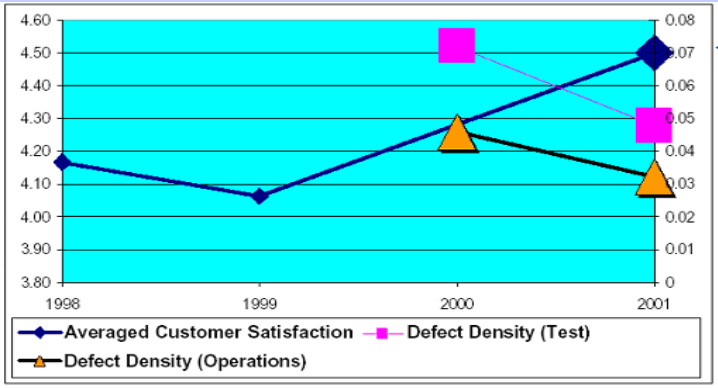
Demonstrating the Impact and Benefits of CMMI: An Update and Preliminary Results, SEI Special Report CMU/SEI-2003-SR-009

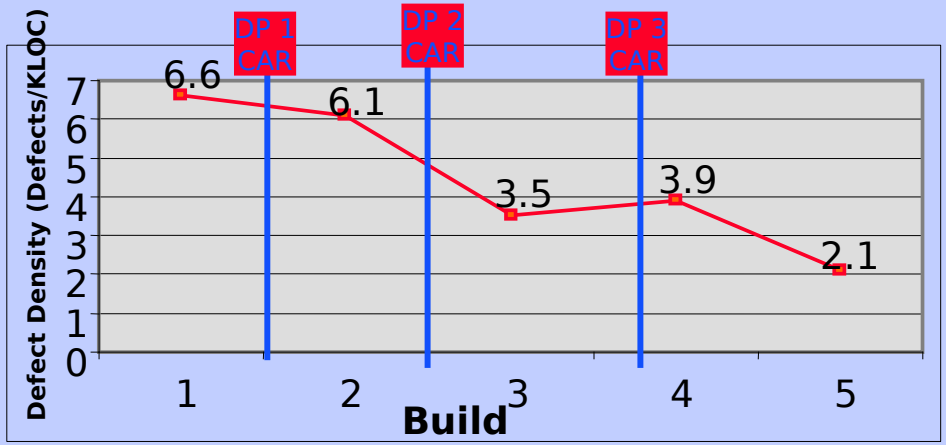
Northrop Grumman Information Technology

- **Defense Enterprise Solutions received CMMI ML 5 in December 2002** **(consolidation of various units using SW-CMM at ML2 – 5, and SE-CMM)**



- Increased quality - only 2% of defects found in fielded system
- Customer satisfaction increases as defects decline
- Causal analysis cycles showed ROI of 13:1 calculated as defects avoided per hour in training





Demonstrating the Impact and Benefits of CMMI: An Update and Preliminary Results, SEI Special Report CMU/SEI-2003-SR-009

Other Notable CMMI "Benefits" Data

General Motors Information Systems and Services – integrates supplier and GM products

- **Met schedules more consistently after transition to CMMI**
  - **Increased number of project milestones from 50% to 85%**
  - **Reduced number of days late from ~50 to less than 10**

Boeing, Australia Ltd. – systems development for commercial and aerospace markets

- **Focus project: transitioning from SW-CMM and EIA 731, to CMMI**
  - **Quantitative**
    - **33% decrease in the average cost to fix a defect**
    - **Turnaround time for releases cut in half**
    - **60% reduction in work from Pre-Test and Post-Test Audits; passed with few outstanding actions**
  - **Qualitative**
    - **Increased focus on product quality**
    - **Increased focus on eliminating defects**
    - **Developers seeking improvement opportunities**

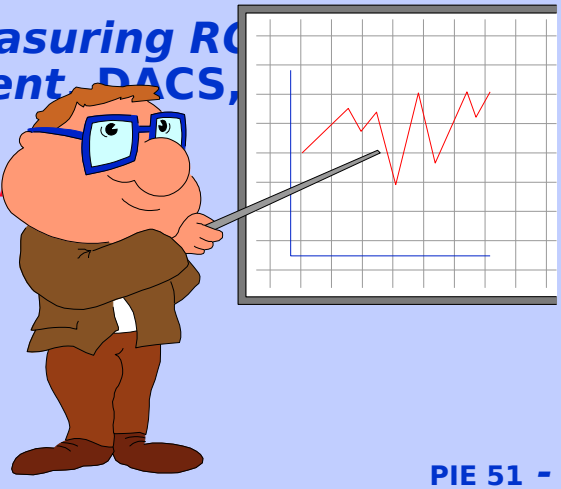
The Business Case

A report by DoD Data & Analysis Center for Software (DACS) found:

- **Application of PI to "Example organization with example projects":**

Development costs	Reduced 73%
Rework costs	Reduced 96%
Average schedule length	Reduced 37%
Post-release defects	Reduced 80%
Weighted risk likelihood	Reduced 92%
Return on Investment	21:1

- ***A Business Case for SPI Revised - Measuring RO*** ***Software Engineering and Management*** **, DACS, 1999**
  see http://www.dacs.dtic.mil/techs/roispi2



Other Intangible Benefits

At Ogden Air Logistics Center:

- Positive influence on working environment; no constraint on creativity
- Beneficial structure provided to the development process
- Fewer surprises and last-minute glitches, “fire drills” reduced
- Better quality software; overtime and unhappy customers reduced

- CrossTalk, May 1999

At Boeing Space Transportation Systems:

- Employee satisfaction up from 74% to 96%
- Employees motivated to eliminate defects, improve quality

-IEEE Software, Sept/Oct 1999

At SSC San Diego:

- Better management control over the project
- Better overall performance of the software
- Improved morale of team members, less overtime, absenteeism
- Better communication among the team
- Increased competitive advantage and repeat business

- Costs and Benefits of SPI, Karen D. Prenger

At multiple sites:

- Improved customer satisfaction
- Improved professional staff

- DACS: Business Case for SPI Revised

Benefits at SSC San Diego

Some testimonials from Level 3 Project Managers regarding results of PI

- **We produced more complex builds in less time**
- **Implementing Peer Reviews and other process improvements significantly reduced the problems found and the testing efforts (e.g., reduced trouble reports by 71%, time to conduct tests by 33%, time to fix all trouble reports by 70%)**
- **Through process maturity we have observed increased productivity**
- **The project people have told me they would not work on another project without defined processes**
- **I travel a lot and having defined processes makes turnover completely seamless between me and my acting**
- **We are now consistently producing builds with zero defects**
- **We have better communication across the team, and people know what they are supposed to be doing**
- **I feel I am a much better project manager**
- **We have fewer surprises, last minute glitches, and fire drills**
- **We have fewer risks this year because we learned from our Risk Management Plan from last year**
- **We have been awarded new work based on our PI efforts**

Benefits at SSC: the MATCALS project

- Life-Cycle Maintenance of 174K SLOC. Achieved CMM Level 2 in January 1999;

Level 3 in October 2000.

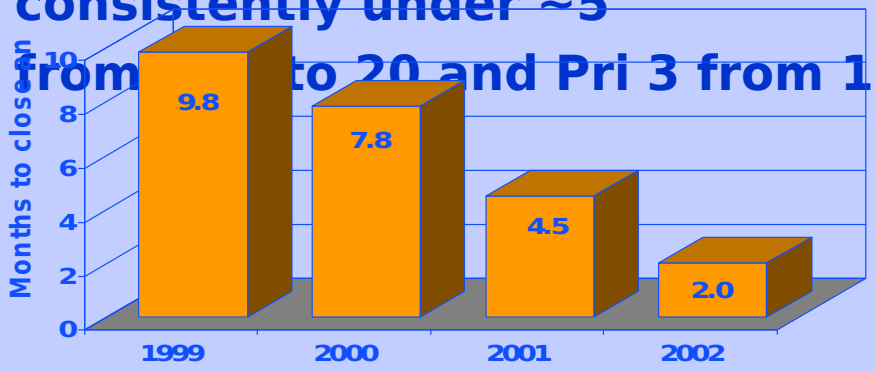
- Improvements and desk-top procedures were implemented in Design, Code, Unit Test, and Peer Reviews over 2.5 years for the Version M release. A comparison of results in the Unit Integration Testing of SCPs, SEPs, and Trouble Reports (TRs):

Measure	Ver. L	Ver. M	Change
a. SCPs and SEPs implemented	16	16	same
b. TRs written and fixed in testing	221	64	71% fewer
c. Total KSLOC modified	26	28	similar
d. Staff months to conduct tests	12	8	33% less
e. Staff months to fix all TRs	57.8	17.3	70% less
d+e Staff months for unit integration tests		69.8	25.3 64% less
e/b Staff months to fix each TR	0.26	0.27	similar
b/d TRs written per staff month testing	18.1	8.0	56% fewer
b/c TRs written per KSLOC modified	8.5	2.3	73% fewer
(d+e)/c Staff months per KSLOC modified	2.7	0.9	67% less

Conclusion: Implementing Peer Reviews and other process improvements significantly reduced the problems found and the efforts expended in testing.

Benefits at SSC: Notable CMMI Data Tactical Communication Solutions (SSC Code 24524)

- Center based product development organization relying on sales (no sponsor) of Data Link Gateway, TADIL J Host Simulator, etc.
- Valuable TCS measurements show improvements (since CMMI in 2000) have resulted in:
  - Avg STR closure time decreased by 80%
  - Average yearly business income increases of 22.3%
  - Significantly low or decreases in number and severity of STRs:
    - Pri 1 consistently under ~5
    - Pri 2 from [illegible] to 20 and Pri 3 from 140 to ~20



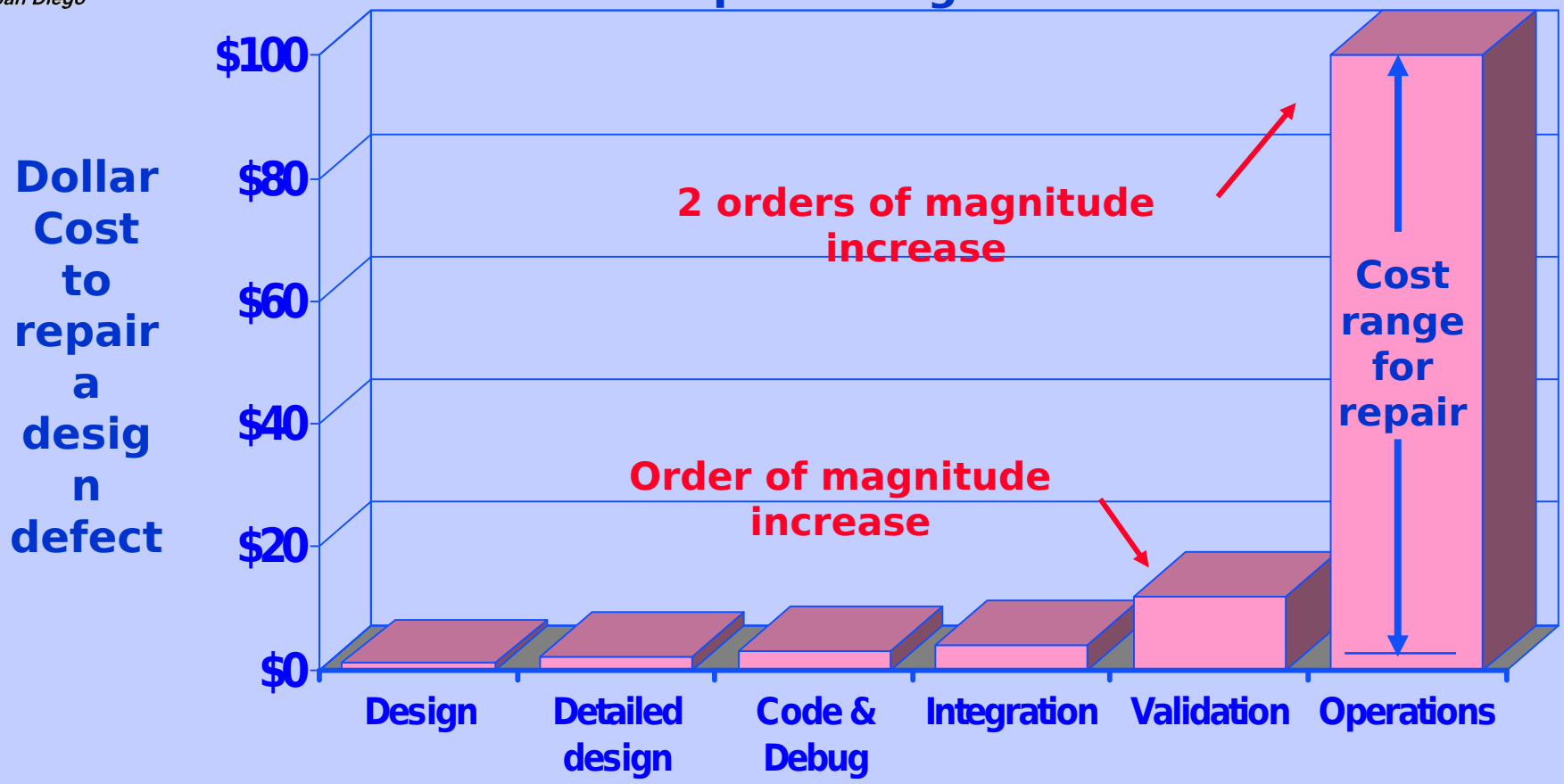
Tactical Communications Solution (TCS) CMMI...ROI? presentation, dated October 2003

More Benefits from SSC San Diego Projects

- Timely deliveries to Fleet — CDLMS
- Developers now understand the requirements — DCT
- Realistic schedules, understanding of requirements — ATDS
- Increased sponsor confidence, improved coordination — KSA
- Morale of team improved — TBMCS
- Peer Review caught code defects before release — SWaT
- We delivered on-time and within budget — WebSKED
- Team members now understand how their roles interact — CoRE
- Less crisis management — GCCS-M
- Reduced risk in the product release cycle — Tact. Comm. Sol.
- Significant reduction of defects in testing — Time Crit. Strike
- We are SO much more organized than we used to be! — JSIMS-M

Example of How PI Can Save Money:

Cost to Repair Design Defects



Phase when design defect was corrected *Source: SEPG Conference, 1999*

SEI found:
- **Rework is 40% - 50% of project costs**
- **High-maturity organizations can get rework to <10% of costs**

(Paulk, 1999)

Defect Detection Changes as Process Maturity Increases

		Req'ts.	Design	Code	Functional Test	System Test	Field Use	Relative Cost for 100 Fixes
Where Defects are Introduced		10%	40%	50%				
Relative Cost to Fix		$1	$1	$1	$6	$12	$100	
Where Defects Are Detected	Level 1	0%	0%	2%	15%	50%	33%	$4,000
	Level 2	0%	0%	3%	30%	50%	17%	$2,500
	Level 3	0%	2%	20%	38%	32%	8%	$1,400
	Level 4	3%	12%	30%	30%	20%	5%	$1,000
	Level 5	5%	20%	40%	20%	10%	<5%	$800

Source: CMI/SEI-96-HB-002

Typical "Roadblock Categories to Best Practices

Resistance to Change

1. "We tried process improvement before, and it didn't buy us anything."
2. "CMM/CMMI and best practices are just another fad."
3. "We have processes and plans, but in a crunch we send in a Tiger Team."

Lack of commitment and resources

4. "Who's paying for it? If it isn't paid for, we're not doing it."
5. "I'm retiring/transferring from this job soon, I don't have to get involved."
6. "We are too busy now to have time for process improvement."

Sponsors have less ability to dictate budgets and schedules

7. "Our schedule is fixed, our resources are fixed, our requirements are fixed, our quality level is fixed."
8. "Our sponsor is happy now, and only interested in short-term results."
9. "Our sponsor doesn't understand or care about process improvement."
10. "Our project is different (it's RAD, it's maintenance, it's a prototype) so this process doesn't apply to us."

Management not fully engaged

11. "Managing requirements is a waste of time; requirements keep changing."
12. "Discipline always interferes with creativity."

Advantages of Best Practices

More business!

a. "We won more business because of our maturity level."
b. "We have lowered our life-cycle costs."
c. "Surviving in our changing environment requires constant adaptation."

Higher probability of meeting budgets, schedules, quality goals

d. "We now have visibility into our development status."
e. "Building quality into products of large size and complexity requires engineering."
f. "Process makes a difference in the quality of the activities and products."

Smoother relationships among sponsors, management, teams, contractors

g. "We have better estimates of our budgets, schedules, and technical requirements."
h. "Our success is dependent on other groups and customers."
i. "One person can't track all the details, and error detection is more probable when the work is examined by more than one person."

Fewer crises; reduced overtime

j. "We can now capture and pass on our lessons learned."
k. "We have fewer fire drills and less overtime."

Higher team morale

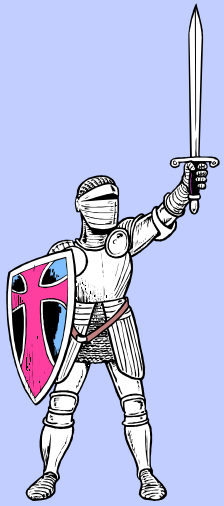
l. "We are more proud of our products, and more satisfied with our work."

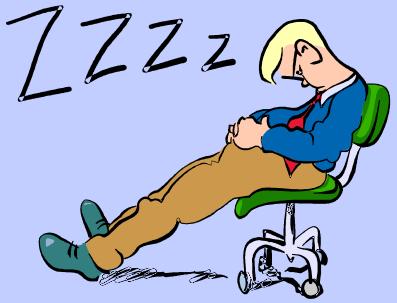
Commitment: Taking an Active Role

"It is not enough that top management commits itself for life to quality and productivity. They must know what it is that they are committed to - that is, what they must do. These obligations cannot be delegated.

Support is not enough. Action is required."
- Dr. W. Edwards Deming

"They watch your feet, not your lips."
- Dr. Tom Peters





What is the real cost of not using Best Practices?

Increased Risk!

	Project A	Project B	Project C	Project D	Project E
Does this:	Code Fix Deliver	Code Fix Deliver	Code Fix Deliver	Code Fix Deliver	Code Fix Deliver
	No Reqts Control *Faulty Design* *Bugs in Delivery*	Requirements Design Test	Requirements Design Test	Requirements Design Test	Requirements Design Test
	Activities unplanned *Unsure of status* *Reqts. not met* *No version control* *No documentation*	*Activities unplanned* *Unsure of status* *Reqts. not met* *No version control* *No documentation*	Plan Track QA CM Document	Plan Track QA CM Document	Plan Track QA CM Document
Has these risks:	*No resources* *No standards* *No prior history* *Untrained people* *Mgt. unaware*	*No resources* *No standards* *No prior history* *Untrained people* *Mgt. unaware*	*No resources* *No standards* *No prior history* *Untrained people* *Mgt. unaware*	PAL OSSP OMDB Training Reviews	PAL OSSP OMDB Training Reviews
	No Dept. comm's *No Org coordination* *Maturity unknown*	*No Dept. comm's* *No Org coordination* *Maturity unknown*	*No Dept. comm's* *No Org coordination* *Maturity unknown*	*No Dept. comm's* *No Org coordination* *Maturity unknown*	SEPG SEPO SCAMPIs

Do Best Practices "Guarantee" Success?

No, but if you fail, don't fail because of:

- **Lack of stated project goals and purpose;
  or failure to tie goals to business objectives**
- **Poor/lack of project planning**
- **Poor/lack of estimation**
- **Poor requirements definition/No requirements management**
- **Unable to deliver product within budget and schedule**
- **Poor contractor management**
- **Poor/lack of attention to COTS integration issues**
- **Lack of training**
- **No/poor risk management**
- **No/poor configuration management**
- **No/poor quality assurance**
- **Inadequate resources and unrealistic expectations**
- **Poor/lack of communication**

Best Practices keep you from failing for preventable reasons.

SPI Incentives: from DoD

DoD Directive 5000.1: Defense Acquisition System, (updated May 12, 2003)

Updated to provide guidance (rather than direction) on tailoring program strategies and oversight: evolutionary acquisition strategies are the preferred approach to satisfying operational needs; spiral development is the preferred process for executing such strategies; and adopt innovative practices (including best commercial practices and electronic business solutions) that reduce cycle time and [illegible] encourage teamwork.

NAVAIR Memo 3100 of 14 March 2000: Level 3 http://dod5000.dau.mil/ :

requirements will apply to all ACAT programs… …contractors (read as government or commercial) will be evaluated to determine if they are fully compliant with SEI SW-CMM Level 3 (or equivalent). If not, then a risk mitigation plan and schedule must be prepared by the bidder and submitted as part of the proposal to describe in detail what actions are planned in order to substantially lower program risks and costs.

Understanding Best Practices: Summary

You should now know:

1. **Which companies have reported benefits from Best Practices?**
2. **Which DoD organizations have reported benefits from Best Practices?**
3. **When is the most expensive time to correct a defect?**
4. **What does DoD require concerning Best Practices and the CMM/CMMI?**
5. **Advancing from which CMM level to the next provides the most results (according to Motorola)?**
6. **What happens if we don't use Best Practices?**